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(54) Title: SURVEILLANCE SYSTEM

(57) Abstract: A security surveillance system is described incorporating a plurality of surveillance devices including a plurality of imaging devices, and at least one of a remote monitoring centre for monitoring of images produced by the imaging devices and a remote recording centre for recording of images produced by the imaging devices. The system is arrayed as a plurality as network nodes, at least some of which nodes include one or more imaging devices, and at least one of which nodes includes a monitoring centre and/or recording centre, wherein each node is in direct network connection to at least two other nodes. In particular the network is cellular in that at least three network nodes are arrayed in a ring wherein each node is in direct network connection to the two neighbouring nodes in the ring, and the overall array comprises a plurality of such rings to produce a cellular, honeycomb-like network structure. A method of use of such a system in an urban environment is also described.

SURVEILLANCE SYSTEM

The invention relates to a surveillance system including a plurality of imaging devices such as cameras arrayed to monitor an area under surveillance. In particular, the invention relates to an external, urban community estate surveillance system comprising a plurality of imaging devices disposed around the urban environment for real time imaging thereof, linked to a central control for monitoring and recording of surveillance information.

Surveillance systems, and in particular surveillance systems incorporating visual imaging and recording means, particularly moving imaging means such as video cameras, have long been recognised as a useful deterrent to undesirable criminal activity in an area under surveillance, and as a useful investigative tool following such criminal or undesirable activity.

Originally, such systems were used in relation to relatively small self-contained and generally indoor or partially indoor environments. For example, video surveillance has been widely used in the prevention of crime in shops, shopping centres and the like, and has been used for security surveillance in multi-storey car parks, railway stations and transport interchanges, and other similar public areas.

However, in recent years, there has been an increasing move towards providing video based surveillance on a larger, and more generally outdoor scale. For example, surveillance systems may be used to monitor urban environments which have a history of problems, such as town centres and urban estates. Generally speaking, these systems have been based on a similar approach to that used for the smaller scale indoor systems, but their size and nature is such that technical considerations are not necessarily identical.

Traditional video surveillance systems consisted of an array of video cameras, each connected to a central control, typically by a dedicated hard wired link which transmitted the imaging signal to the central control, and optionally also transmitted control systems for the camera outward from the central control. The control was typically provided with a number of TV screens or other monitors to allow real time monitoring of the images by security personnel, and also generally provided for recording of images for future reference on video tape or similar recording means.

Such a simple system works relatively well on the small scale particularly in relation to older analogue technology, and particularly in indoor environments where the wiring between imaging units and control could be incorporated into the building structure. However, extension of systems to a larger outdoor urban environment scale is not entirely straightforward. On such a scale, the system can become unwieldly, particularly in relation to conventional analogue video tape recording, whilst the provision and maintenance of direct hardwired links between a control and more remotely spaced device becomes more expensive, particularly having regard to the cabling requirements imposed by the large bandwidth needed for effective transmission of analogue video signals over any distance.

These considerations, coupled with the development of digital alternatives in relation to all aspects of the surveillance system, have led to an increasing trend to consider the advantages which might be offered by digital technology. For example, analogue video cameras have been replaced by digital cameras and/or analogue hard wired connections by digital connections, for example dial up connections using an integrated services digital network (ISDN) protocol and/or digital storage techniques have been used for data storage

and/or digital display units have been used for monitoring. However, none of these systems have fully exploited the potential of digital technology. In particular, constraints imposed by conventional thinking in relation to many systems have meant that only certain elements have been digitised. In consequence, the systems become more complicated by the need to provide analogue to digital and digital to analogue converters at various points. Moreover, all of the systems have relied on a connection between a surveillance device and control which is either through a direct line, (for example an ISDN dial up) or through a tree-type network. On larger scales, maintaining such arrays over the distances involved becomes complex.

It is an object of the present invention to provide an improved surveillance system incorporating a plurality of imaging devices arrayed about an area to be kept under surveillance which mitigates some or all of the above disadvantages.

It is a particular object of the present invention to provide a surveillance system which takes a better advantage of the potential of digital technology than has been the case hitherto by ensuring that the system is more fully integrated.

It is a particular object of the present invention to provide a surveillance system which is suited to a large scale outdoor urban environment, and which exploits features of that environment to operate efficiently.

Thus, according to a first aspect of the present invention, a security surveillance system comprises a plurality of surveillance devices including a plurality of imaging devices, and at least one of a remote monitoring centre for

monitoring of images produced by the imaging devices and a remote recording centre for recording of images produced by the imaging devices, the system being arrayed as a plurality as network nodes, at least some of which nodes include one or more imaging devices, and at least one of which nodes includes a monitoring centre and/or recording centre, wherein each node is in direct network connection to at least two other nodes.

In accordance with the invention, the system takes the form of an array of network nodes which are arranged as a true network, in that each node is functionally connected via a suitable network pathway means to at least two (conveniently adjacent) other nodes. Each node having associated imaging device(s) serves as a transceiver to transmit imaging data generated by imaging device(s) associated with itself, and to receive and retransmit imaging data obtained from those nodes to which it is connected through the said network pathways means.

The surveillance system is thus arrayed as a true network (which in the context of the present invention is used to mean that no node on the network has only a single connection) which contrasts markedly with conventional surveillance systems. Overcoming the long-standing conventional prejudices regarding the arrangement of surveillance systems, and in particular the arrangement of the devices relative to the communication pathways, and taking instead the radically different approach of providing a true network offers significant technical advantages. In particular this arises in relation to the multiple communication pathways the network offers, and the inherent robustness generated in the system by such redundancy, the transceivers comprising the network nodes being able to seek out alternative routes to the monitoring and/or recording centre if any data network pathway is down for any reason.

In a particular preferred embodiment, the network is cellular. That is, a small number of network nodes (at least three, and for example 3 to 7) are arrayed in a ring wherein each node is in direct network connection to the two neighbouring nodes in the ring, and the overall array comprises a plurality of such rings to produce a cellular, honeycomb-like network structure.

It will be apparent to the skilled person that such a cellular structure maximises the efficiency of the network connections. Within the body of the network, nodes will form part of two or more cells, and consequently be provided with three or more data network connections to adjacent nodes. However, it can be seen that the relatively few and relatively short extra network pathway means which are necessary to produce a cellular network structure result in a huge and disproportionate increase in the length and number of overall network pathways available for data communication through the network, and in the robustness of the network arising out of this increased redundancy. Thus, a cellular arrangement as above described exploits the network effect to the full.

By making this radical departure from longstanding conventional arrangements and arranging the surveillance devices as a true network, and in particular a cellular network, the invention enables the surveillance system to be adapted to exploit network technology, and in particular cellular network technology to the full. In particular, the novel network is especially adapted to the use of digital technology throughout. Therefore, the imaging devices are preferably digital imaging devices and/or the data network connection between nodes is preferably provided by digital network pathway means and/or the network nodes preferably act as transceivers for digital data transfer, and/or the monitoring centre preferably comprises digital image display means, and/or the recording centre preferably comprises means for

digital recording and retrieval of imaging information. The digital data storage means may comprise any suitable digital data storage. In practise, this will be preferably a suitable memory on a suitably configured computer, which memory may be rewriteable or not. Suitable data retrieval software is preferably provided.

The surveillance system network preferably includes both at least one monitoring centre and at least one recording centre. These may be located at the same position on the network (i.e. at the same node) or in different positions. The or each monitoring centre preferably comprises a plurality of image display screens, in particular digital image display screens, viewable by one or more human users to permit real time monitoring by security personnel of the images.

Means are preferably provided in the system to record information, such as date, time and location, in relation to the image and to allow this information to be retrieved in association with the retrieval of the image. Conveniently, the system therefore further comprises a timing device to generate time related information, which may for example be the internal clock of the data storage computer system.

Additionally, a control centre may be provided, which may be co-located with either or both of the above, for transmission of control signals to the surveillance devices. Control signals may include, for instance signals to switch the surveillance devices such as the imaging devices on or off, signals to move the surveillance devices so as to change the area under surveillance (for example by rotating or altering the angle of elevation of a imaging device to alter the area being imaged) or other necessary control systems. In such a network, the transceivers comprising network nodes also serve to receive and

onwardly transmit control signals from the control centre, and the surveillance devices to be controlled are provided with control means to act under the control of a control signal from the control centre.

Data transfer between nodes may follow any protocol suited to the transfer of data through a digital network. In particular, the novel network structure allows exploitation of established technologies in relation to Ethernet and like networks applied in other arts. The transceivers comprising the nodes will be adapted to employ a switching protocol or protocols which exploit to the full the multiple network pathways provided by the system to ensure that if any link is temporarily unavailable, a through path may still be found. In particular, the transceivers will act to transmit data between network nodes in a switched packet form using a suitable multiplexed wood protocol. For example, the transceivers may be adapted to transmit data in asynchronous transfer mode (ATM).

Preferably, the imaging devices provide for real-time imaging of the environment under surveillance, and in particular provide for real-time moving or pseudo-moving imaging of the areas under surveillance.

The imaging devices may image in any part of the spectrum which provides useful information. In practice, for the purposes envisaged, imaging in the visible spectrum and/or the infra-red spectrum will be most use. The system preferably includes imaging devices capable of imaging in the visible spectrum and/or imaging devices capable of imaging in the infra-red. The optimal layout will be determined by the environment in which the system is to be deployed, but will frequently include a combination of visible frequency and infra-red devices. Additionally or alternatively imaging devices may be provided which are sensitive to either frequency range, for example being

capable of being switched between an infra-red and a visible mode of operation dependent upon ambient light conditions or other considerations.

Although the invention is primarily directed at a network for video-type surveillance, it will be readily understood that other security devices could be incorporated additionally into the network as the needs of the environment dictated. These could include, for example, motion detectors, infra-red detectors, intruder detectors such as pressure pads, trip switches, trip beams or the like or any other suitable devices to complement the imaging devices and enhance the security offered by the overall surveillance system.

Each network node as above described may itself be a single surveillance device or control/recording/monitoring centre as the case may be. Alternatively, the network nodes may comprise a primary network, in which some or all of the network nodes have associated a plurality of surveillance devices, such as a plurality of imaging devices in a secondary array. For example, in application in an external urban environment, the network nodes may comprise large buildings or other significant centres on an urban estate, with each network node having associated a plurality of surveillance devices arrayed as a secondary array throughout the building or local area.

Such secondary arrays of devices may be conventionally arrayed (for example, each in direct data connection to the transceiver comprising the node making up the primary network) or may be arranged in a secondary network, and in particular in a secondary cellular network, in like manner to the primary network. It will be appreciated that the same advantages will be conferred by arranging the devices in such a secondary network. However, these advantages might not be so important in the context of the application of the invention. For instance, in the example given, where the primary network

nodes represent large buildings or locations, with the secondary array being within the building or local area, the scale of the secondary array is such that a conventional arrangement using direct hardwired connections may be appropriate for the secondary array but not for the primary network.

The system may operate on more than two levels, that is may comprise a primary array of nodes networked in accordance with the invention, and at least one intermediate level array of nodes which may or may not be networked in accordance with the invention, with the (or the lowest level) intermediate node having associated an array of surveillance devices (which again may or may not be networked according to the invention).

It is a particular advantage of the present invention that the multiple pathways and inherent redundancy and robustness provided by the cellular structure lends itself to the use of wireless technology. Individual wireless connections are notoriously brittle compared with hard wired connections, being susceptible to environmental disturbance, line of sight interruptions, interference effects and other problems which will be familiar. This has hitherto rendered impractical their use in surveillance systems, particularly when operating on a large scale. However, the multiple redundant pathways offered by a network and in particular a cellular network in accordance with the present invention produce an inherently robust overall structure which makes practical the use of wireless technology for the individual data network pathways. This offers huge practical advantages, particularly in relation to costs considerations, when compared with a large-scale network connected either by dedicated hard-wired links, or by ISDN dial-up connection.

Thus, preferably, at least some of the network pathways between network nodes (in at least the primary network where a plurality of network levels are

provided) comprise wireless network pathways, the said network nodes consequently comprising wireless transceivers. In particular, the network pathways are provided, and the transceivers operate, at microwave frequencies.

The invention is particularly suited to application to community based security systems on urban estates. In accordance with a further aspect of the invention, there is provided the use of the above surveillance system in an urban environment, and in particular in an urban estate environment, wherein the (or the primary) network nodes are located at large buildings and other key locations, each network node having associated therewith a plurality of surveillance devices located throughout the building or local area.

In particular, at least some of the network nodes are located on high-rise buildings, and the transmission pathways, at least between those network nodes, are wireless pathways. It has surprisingly been found that such an urban environment lends itself especially well to wireless networking, since the general shape of the environment typically provided by high-rise buildings with open spaces between produces a ready-made structure.

In accordance with a further aspect of the invention, a method of arranging a surveillance system comprising a plurality of surveillance devices including a plurality of digital imaging devices, and at least one of a monitoring centre and a recording centre, and optionally further a control centre, comprises the steps of: arranging the system into a network comprising a plurality of network nodes, at least some of said nodes being in data communication with one or more imaging (and in particular digital imaging) devices, and at least one of said nodes comprising a monitoring and/or recording centre, and providing transceivers at each such node in data communication with the surveillance

device(s) associated therewith to transmit and receive information from at least two other such nodes.

In a preferred embodiment of the method, the transceivers making up the network nodes are arranged on large buildings and other key locations within an urban environment to be kept under surveillance, and a plurality of surveillance devices are arrayed within the buildings or in the local area of the key locations as the case may be in data communication with said transceivers.

Other embodiments of the method will be appreciated by analogy with the above.

The invention is illustrated with reference to an embodiment of the invention applied to an urban estate environment in the accompanying drawings.

In Figure 1, a typical distribution network is shown schematically. The nodes comprise a monitoring centre (1) and a plurality of distribution points (2a, 2b, 2c) located around an urban estate environment, all linked together by microwave transceivers (3). The distribution points include tower blocks (2a), other buildings (2b), and other sites (2c) to be monitored.

The distribution points and the monitoring centre are linked together in a network by microwave transceivers (6).

The monitoring centre (1) is linked via a firewall (5) to external security services (9) such as police or fire and rescue, or to an internet monitoring service.

A distribution point is shown in greater detail in Figure 2. The distribution point consists of a main microwave transceiver (6) on the roof of the building, which is provided with wireless links to CCTV cameras (7) located in various buildings (8) in the vicinity.

A monitoring centre is shown in greater detail in Figure 3. Signals are received from the network via the microwave transceivers (4), passed through a Giga Bit switch (11) to monitoring stations (12). In the embodiment, a dual screen management/training station (14) is also provided. The system is under control of a DELL alarm server (17) processing video data (18), and an ADIC archive video server (19) referring to a 6 Terabyte autoloader tape archive (20). Thus the system allows for both human monitoring and automatic recordal monitoring of the information received from the CCTV cameras.

CLAIMS

1. A security surveillance system comprises a plurality of surveillance devices including a plurality of imaging devices, and at least one of a remote monitoring centre for monitoring of images produced by the imaging devices and a remote recording centre for recording of images produced by the imaging devices, the system being arrayed as a plurality as network nodes, at least some of which nodes include one or more imaging devices, and at least one of which nodes includes a monitoring centre and/or recording centre, wherein each node is in direct network connection to at least two other nodes.

2. A surveillance system in accordance with claim 1 wherein the network is cellular in that at least three network nodes are arrayed in a ring wherein each node is in direct network connection to the two neighbouring nodes in the ring, and the overall array comprises a plurality of such rings to produce a cellular, honeycomb-like network structure.

3. A surveillance system in accordance with claim 2 wherein each ring comprises three to seven network nodes.

4. A surveillance system in accordance with any preceding claim wherein the imaging devices are digital imaging devices.

5. A surveillance system in accordance with any preceding claim wherein the data network connection between nodes is provided by digital network pathway means and/or the network nodes act as transceivers for digital data transfer.

6. A surveillance system in accordance with any preceding claim wherein the monitoring centre comprises digital image display means, and/or the recording centre preferably comprises means for digital recording and retrieval of imaging information.

7. A surveillance system in accordance with any preceding claim including at least one monitoring centre and at least one recording centre.

8. A surveillance system in accordance with any preceding claim wherein the or each monitoring centre comprises a plurality of image display screens viewable by one or more human users to permit real time monitoring by security personnel of the images.

9. A surveillance system in accordance with any preceding claim further comprising a control centre for transmission of control signals to the surveillance devices.

10. A surveillance system in accordance with any preceding claim wherein the transceivers comprising the nodes are adapted to employ a switching protocol or protocols which exploit to the full the multiple network pathways provided by the system to ensure that if any link is temporarily unavailable, a through path may still be found.

11. A surveillance system in accordance with Claim 10 wherein the transceivers are adapted to transmit data between network nodes in a switched packet form using a suitable multiplexed protocol.

12. A surveillance system in accordance with any preceding claim comprising a plurality of imaging devices for video surveillance, and incorporating additionally into the network other security devices

selected from motion detectors, infra-red detectors, intruder detectors such as pressure pads, trip switches, trip beams or the like or any other suitable devices to complement the imaging devices and enhance the security offered by the overall surveillance system.

13. A surveillance system in accordance with any preceding claim wherein the network nodes may comprise a primary network, in which some or all of the network nodes have associated a plurality of surveillance devices, such as a plurality of imaging devices, in a secondary array.

14. A surveillance system in accordance with Claim 13 in application in an external urban environment, wherein the network nodes comprise large buildings or other significant centres on an urban estate, with each network node having associated a plurality of surveillance devices arrayed as a secondary array throughout the building or local area.

15. A surveillance system in accordance with Claim 13 or Claim 14 wherein the secondary arrays of devices are arrayed each in direct data connection to the transceiver comprising the node making up the primary network.

16. A surveillance system in accordance with one of Claims 13 to 15 wherein the secondary arrays of devices are arrayed in a secondary cellular network in like manner to the primary network.

17. A surveillance system in accordance with any preceding claim wherein at least some of the network pathways between network nodes comprise wireless network pathways, the said network nodes consequently comprising wireless transceivers.

18. A surveillance system in accordance with Claim 17 wherein the network pathways are provided, and the transceivers operate, at microwave frequencies.

19. The use of a surveillance system in accordance with any preceding claim in an urban environment, and in particular in an urban estate environment, wherein the (or the primary) network nodes are located at large buildings and other key locations, each network node having associated therewith a plurality of surveillance devices located throughout the building or local area.

20. The use in accordance with Claim 19 wherein at least some of the network nodes are located on high-rise buildings, and the transmission pathways, at least between those network nodes, are wireless pathways.

21. A method of arranging a surveillance system comprising a plurality of surveillance devices including a plurality of digital imaging devices, and at least one of a monitoring centre and a recording centre, and optionally further a control centre, comprises the steps of: arranging the system into a network comprising a plurality of network nodes, at least some of said nodes being in data communication with one or more imaging devices, and at least one of said nodes comprising a monitoring and/or recording centre, and providing transceivers at each such node in data communication with the surveillance device(s) associated therewith to transmit and receive information from at least two other such nodes.

22. The method in accordance with Claim 21 wherein the network is cellular in that at least three network nodes are arrayed in a ring wherein each node is in direct network connection to the two neighbouring nodes in

the ring, and the overall array comprises a plurality of such rings to produce a cellular, honeycomb-like network structure.

23. The method in accordance with Claim 21 or Claim 22 wherein the transceivers making up the network nodes are arranged on large buildings and other key locations within an urban environment to be kept under surveillance, and a plurality of surveillance devices are arrayed within the buildings or in the local area of the key locations as the case may be in data communication with said transceivers.

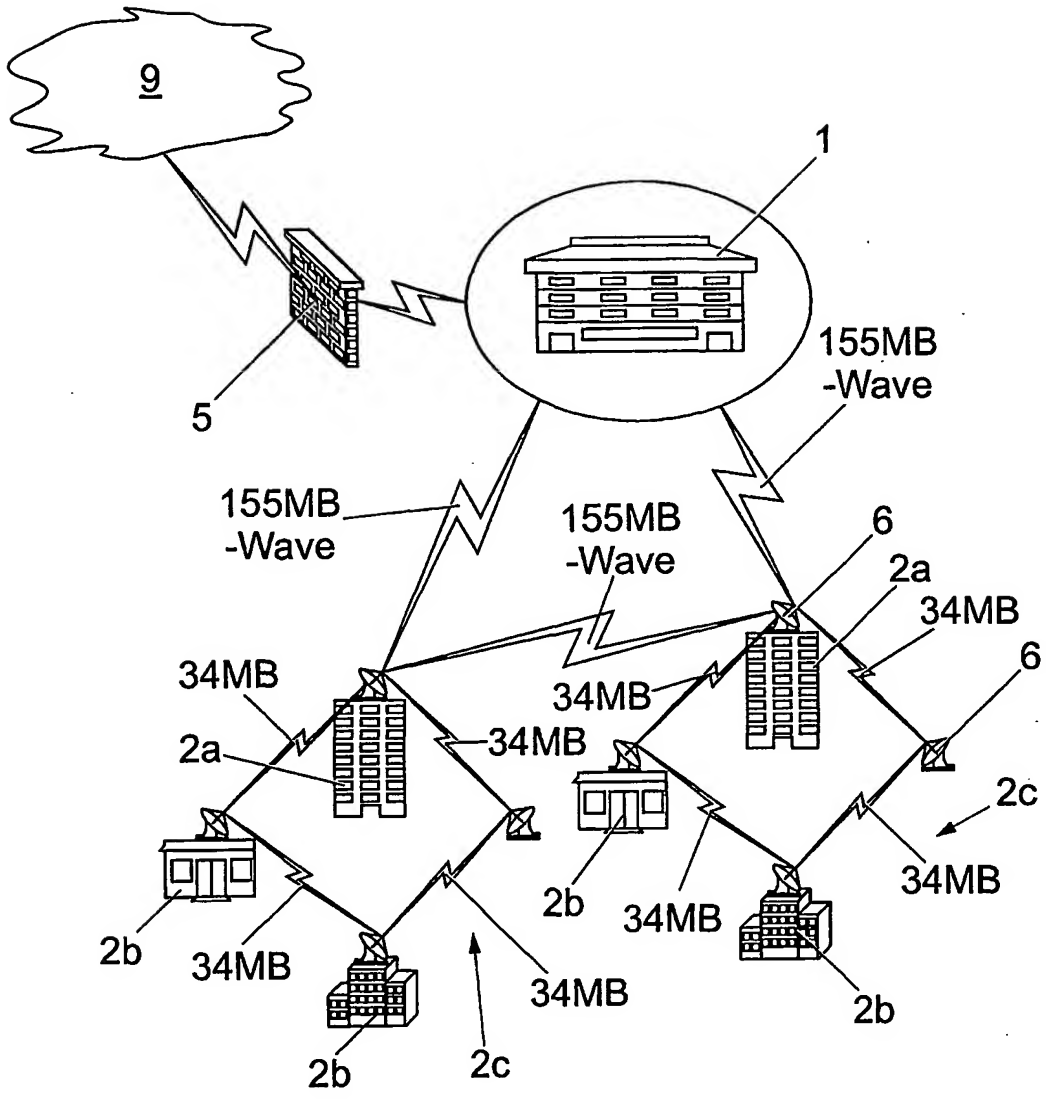
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Fig. 1

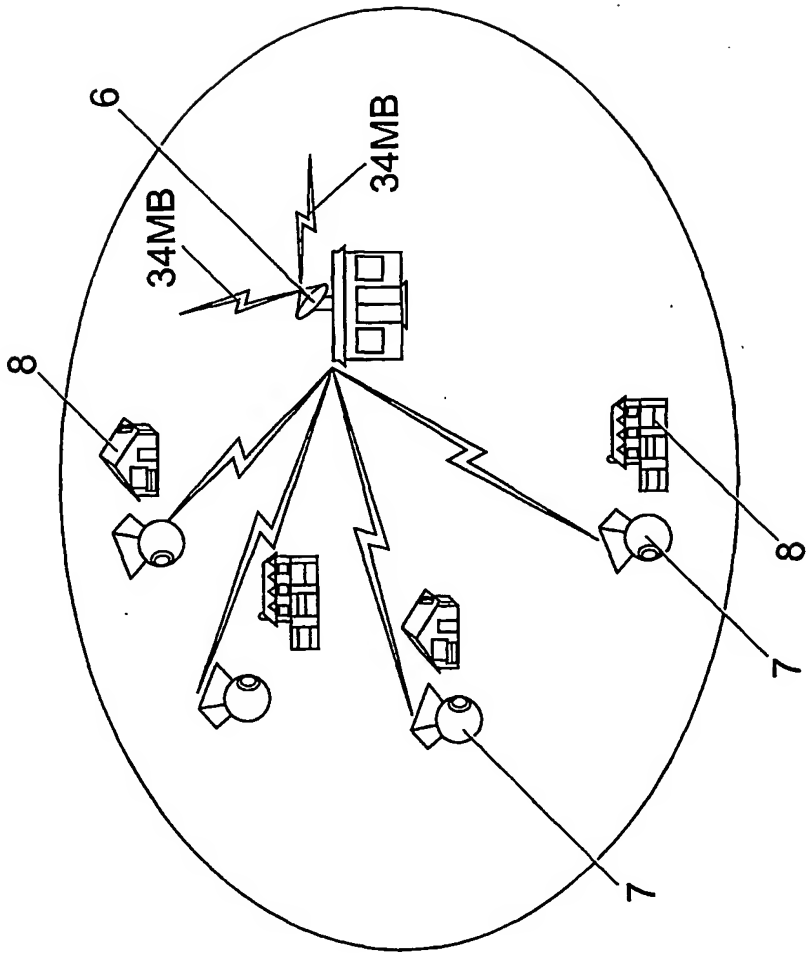

Fig. 2

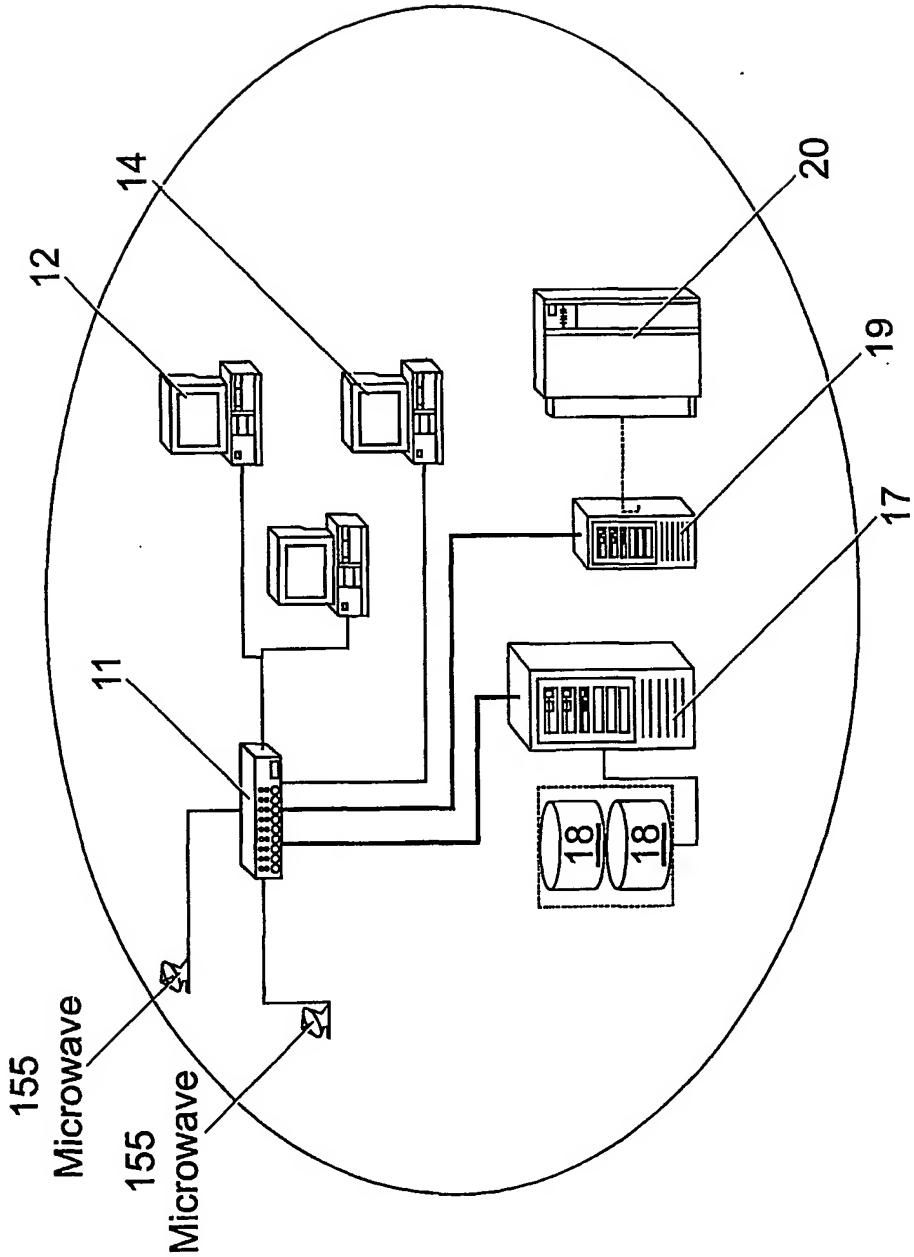

Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/02827

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N7/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 867 484 A (SHAUNFIELD JOHN E) 2 February 1999 (1999-02-02) column 3, line 66 -column 4, line 13 column 5, line 41 -column 7, line 48; figure 2	1,4,5, 12,21
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A	GB 2 256 771 A (CABLE SRL) 16 December 1992 (1992-12-16) abstract page 8, line 11 -page 9, line 33; figures 4,5	1,2,6, 17,21,22

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 September 2001	28/09/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Fuchs, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/GB 01/02827

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